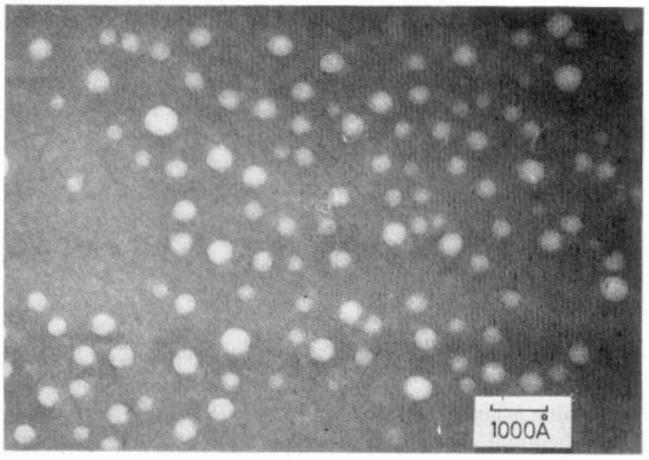


Figure 1. Electron micrograph of didodecyldimethylammonium bromide vesicles. (135 000 ×). The sample solution was sonicated in the absence of uranyl acetate.

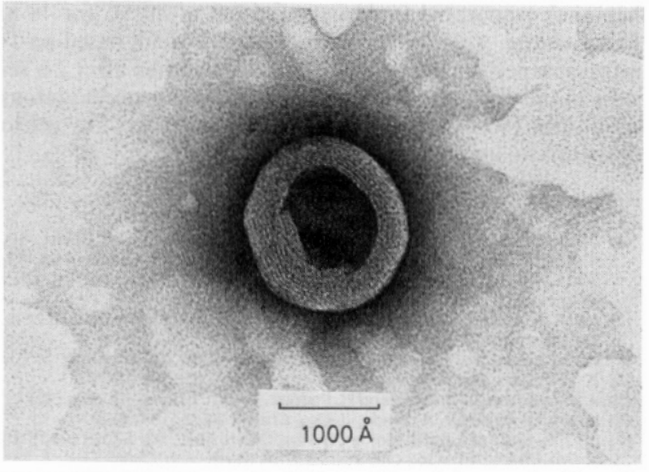


Figure 2. Electron micrograph of didodecyldimethylammonium bromide vesicles. (240 000 ×). The sample solution was sonicated in the presence of uranyl acetate.

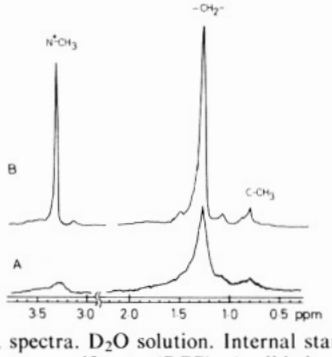


Figure 3. ^{1}H NMR spectra. D_2O solution. Internal standard, sodium 2,2-dimethyl-2-silapentanesulfonate (DSS): A, didodecyldimethylammonium bromide, 10 mM; B, hexadecyltrimethylammonium bromide, 10 mM.

cedure was omitted, the lamellar structure was observed instead of vesicles. Also, the same aqueous solution of didodecyldimethylammonium bromide was mixed with an equal amount of the uranyl acetate solution, sonicated for 10–15 min and applied to a copper grid. An electron micrograph of this sample indicates the presence of multilayered vesicles (diameter, 1000–2000 Å) which contain uranyl acetate in the interior region (Figure 2). The thickness of the layer is about 40 Å both in the lamellar structure and in the multi-layered vesicle.

The light scattering experiment (FICA, Model 4200) with a well-sonicated solution of the ammonium salt indicated the molecular weight of the vesicle to be ca. 700 000. Figure 3 shows a ^{1}H NMR spectrum (D_2O solution) of the ammonium salt obtained at the ambient temperature, in comparison with that of hexadecyltrimethylammonium bromide. The methyl and methylene proton peaks of the former compound are considerably more broadened than those of the latter which exist as micelles at the concentration range employed.

These results suggest that didodecyldimethylammonium bromide aggregates extensively in aqueous solutions into stable bilayer structures which further form vesicles and lamellae. The aggregation in water of ammonium compounds with two long-chain alkyl groups has been known for some time. However, the aggregate structure was never discussed[2] or was considered simply liquid-crystalline.[3]

The present finding is the first example of the totally synthetic bilayer membrane, and, apart from its relevance to the physical chemistry of biomembranes, this system will be used for preparing well-defined molecular organizations which possess various functions. The formation of the bilayer structure from a variety of related compounds and their physicochemical characterization will be the subject of later publications.

Acknowledgment. We deeply appreciate Professor M. Takayanagi (Kyushu University) for the use of an electron microscope, and Dr. K. Kamide (Asahi Chemical Co.) for the use of a light scattering instrument.

References and Notes

(1) M. P. Sheetz and S. I. Chan, *Biochemistry*, **11**, 4573–4581 (1972).
(2) A. W. Ralston, D. N. Eggenberger, and P. L. DuBrow, *J. Am. Chem. Soc.*, **70**, 977–979 (1948).
(3) H. Kunieda and S. Shinoda, Paper presented at the 34th annual meeting of the Chemical Society of Japan, Tokyo, April 1976

Toyoki Kunitake,* Yoshio Okahata
Department of Organic Synthesis
Faculty of Engineering, Kyushu University
Fukuoka, 812, Japan
Received December 28, 1976

Reactions in Dry Media. A Simple Conversion of Nitro Groups into Carbonyls

Sir:

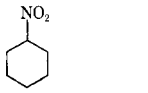
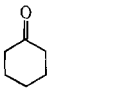
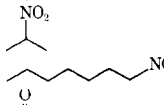
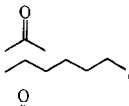
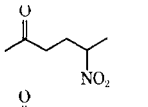
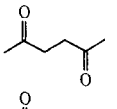
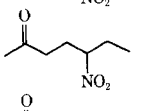
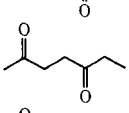
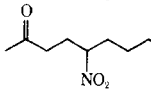
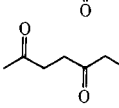
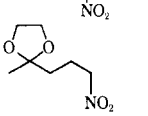
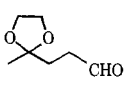
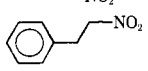
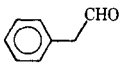
Silica gel as a reaction medium is of great advantage when the use of organic solvents is undesirable, as in the case of ozonation reactions. Dry reactions on silica gel[1] are often neater and easier to perform than solution reactions. We have recently used such dry ozonations to oxidize amines to nitro compounds.[1d]

We report on the utilization of silica gel both as a reaction medium and a reagent to convert nitro compounds to ketones and aldehydes. This nitro to carbonyl group conversion is well known and of considerable synthetic value. It has previously been accomplished by acid catalyzed hydrolysis of nitronate salts—the Nef reaction.[2] This reaction has several synthetic drawbacks, the most noticeable of which being the required strong acid conditions. In order to overcome these drawbacks, several roundabout methods were devised during the last 2 decades, using either oxidizing[3-6] or reducing[7-9] agents.

Our approach reverts to the original Nef reaction, consisting of a simple, one step procedure which is both effective and mild. It involves embedding the nitro compound into activated basic silica gel and elution of the resulting carbonyl derivative.

The basic silica gel[10] is readily prepared by mixing chromatographic grade silica gel with a methanolic solution of sodium methoxide, followed by evaporation to dryness and heating at 400 °C for several hours. The resulting dry powder (contining 0.5 equiv of sodium per 1 kg of silica gel) can be

Table I

Starting material	Product	% yield[c]
		99[a]
		97[a]
		87[b]
		81[b]
		84[b]
		80[b]
		81[b]
		60[b]

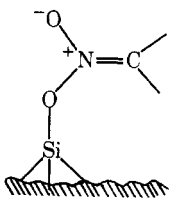
[a] At room temperature. [b] At 80 °C. [c] Based on GC measurements.

stored in closed bottles, but when left open, it slowly absorbs water, up to 3–5% of its weight, without appreciable loss of activity. Silica gel containing higher concentrations of sodium ions may also be used (up to 4 equiv/1 kg); however, the more basic silica gel may affect condensation reactions of the product.[10b]

The following example illustrates the simplicity of this method: 0.5 g of nitrocyclohexane was mixed with 50 g of activated basic silica gel for ca. 2 min and then left in a closed bottle at room temperature for 48 h. Elution of the resulting yellow[11] silica gel with ether gave 0.38 g (99%) of cyclohexanone, chromatographically pure. The reaction time becomes shorter if the adsorbed silica gel is heated. For example, at 80 °C, the reaction is completed within 2 h, with 91% yield of the pure product.

Table I shows that both primary and secondary nitro compounds are converted to the corresponding aldehydes and ketones. Generally, an additional carbonyl group does not interfere with these conversions, the exceptions being the 1-nitro-4-ketoalkanes, which are inert to the basic silica gel.[12] Thus, in order to obtain 4-ketopentanal, it was necessary to mask the keto function of the 1-nitropentan-4-one by a ketal group.

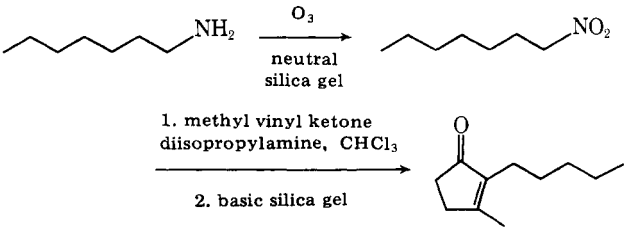
We assume that the first step in these conversions is the formation of nitronate ion,[15,16] which reacts with the siloxane function of the silica gel[17] resulting in a mixed anhydride[18] of the nitronic acid and poly(silicic acid) (I). This intermediate



I

is then attacked by the silanoxide or by adsorbed hydroxide anion,[19] resulting in the carbonyl derivative and nitrogen oxides (we have found both nitrite and nitrate ions in the water eluate of the silica gel following elution with the organic solvent).

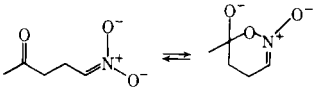
The usefulness of dry silica gel both as a reaction medium and a reagent may be illustrated by the technically simple synthesis of dihydrojasmone using *n*-heptylamine as a starting material; ozone (3 equiv) was passed through neutral silica gel



containing *n*-heptylamine (ca. 1%) at −78 °C.[1d] The resulting 1-nitroheptane, eluted with ether as a pure product (70%), was dissolved in chloroform and treated with methyl vinyl ketone (1.1 equiv) and a catalytic amount of diisopropylamine. The total solution was stirred for 5 h at 40 °C, then mixed with basic silica gel (100 times the weight of the starting 1-nitroheptane) evaporated to dryness and left at 80 °C for 48 h. Ether elution gave dihydrojasmone (68% yield, based on 1-nitroheptane). Interruption of the later reaction after 2 h results in the undeca-2,5-dione which under the more rigorous conditions (80 °C, 48 h) cyclizes on the basic silica gel to dihydrojasmone.

References and Notes

(1) (a) Z. Cohen, E. Keinan, Y. Mazur, and T. H. Varkony, *J. Org. Chem.*, **40**, 2141 (1975); (b) Z. Cohen, E. Keinan, Y. Mazur, and A. Ulman, *ibid.*, **41**, 2651 (1976); (c) E. Keinan and Y. Mazur, *Synthesis*, 523 (1976); (d) E. Keinan and Y. Mazur, *J. Org. Chem.*, **42**, 844 (1977).
(2) (a) N. E. Noland, *Chem. Rev.*, **55**, 137 (1955); (b) N. Kornblum and R. A. Brown, *J. Am. Chem. Soc.*, **87**, 1742 (1965).
(3) H. Schechter and F. T. Williams, *J. Org. Chem.*, **27**, 3699 (1962).
(4) A. H. Pagano and H. Schechter, *J. Org. Chem.*, **35**, 295 (1970).
(5) J. E. McMurry, J. Melton, and H. Padgett, *J. Org. Chem.*, **39**, 259 (1974).
(6) N. Kornblum and P. A. Wade, *J. Org. Chem.*, **38**, 1418 (1973).
(7) (a) J. E. McMurry and J. Melton, *J. Am. Chem. Soc.*, **93**, 5309 (1971); (b) *J. Org. Chem.*, **38**, 4367 (1973); (c) J. E. McMurry, *Acc. Chem. Res.*, **7**, 281 (1974).
(8) R. Kirchboff, *Tetrahedron Lett.*, 2533 (1976).
(9) J. R. Hanson, *Synthesis*, *1* (1974).
(10) Silica gel containing sodium ions had been previously prepared by mixing silica gel with aqueous NaOH and was used as a catalyst for vapor phase aldol condensations: (a) J. Malinowski and S. Szezepanska, *J. Catal.*, **2**, 310 (1963); (b) S. Malinowski and S. Basinski, *ibid.*, **2**, 203 (1963).
(11) Colored probably by nitrogen oxides.
(12) The lack of reactivity of 1-nitro-4-ketoalkane to a Nef type reaction is in accordance with previous observations,[13] probably due to formation of a stable cyclic intermediate:[14]



(13) E. E. Van Tamelen and R. J. Thiede, *J. Am. Chem. Soc.*, **74**, 2615 (1952).
(14) H. Schechter, D. L. Ley, and L. Zeldin, *J. Am. Chem. Soc.*, **74**, 3664 (1952).
(15) The basic silica gel contains at least five times more of the sodium ions than of the absorbed nitro derivative.
(16) A low yield conversion of alkali salts of aci-nitro ethylidene and propylidene derivatives to the corresponding 2-en-1,4-dicarbonyls on neutral silica gel was reported: (a) T. Severin and D. Konig, *Chem. Ber.*, **107**, 1499 (1974); (b) H. Lerche, D. Konig, and T. Severin, *ibid.*, **107**, 1509 (1974).
(17) A similar mechanism was proposed for the esterification of silica gel by alcohols: H. Utsugi, H. Horikoshi, and T. Matsuzawa, *J. Colloid Interface Sci.*, **50**, 154 (1975).
(18) Mixed anhydrides of nitronic acid are known to decompose in basic polar solution to yield the carbonyl derivative and nitrogen oxides: E. P. Stefl and M. F. Dull, *J. Am. Chem. Soc.*, **69**, 3037 (1947).
(19) Nef reaction performed under basic conditions reported previously; however, it was explained by a neighboring group participation: H. Wilson and E. S. Lewis, *J. Am. Chem. Soc.*, **94**, 2283 (1972).

Ehud Keinan, Yehuda Mazur*

Department of Organic Chemistry
The Weizmann Institute of Science
Rehovot, Israel

Received January 5, 1977